



Energy+Environmental Economics

Draft Results from 33% RES Economic Modeling

California Air Resources Board

May 20, 2010

Arne Olson, Partner

Agenda

- Review of 33% RES Calculator
- Treatment of Out-of-State REC Transactions
- Draft Results



Energy+Environmental Economics

2



RES Calculator Review

33% RES Calculator

- CARB economic modeling will rely on the E3 RES Calculator
 - Spreadsheet model initially developed by E3 for CPUC's June 2009 *33% RPS Implementation Analysis* report
 - Substantial modifications for ARB 33% RES Rulemaking
- Model generates plausible resource portfolios for serving California load in 2020 under 20% and 33% renewables requirements
- Spreadsheet model allows easy modeling of alternative scenarios
 - Low Net Short vs. High Net Short
 - Treatment of Out-of-State REC transactions



Proposed Regulation and Alternatives Modeled

- **Business-as-Usual:** Statutory 20% RPS requirement applied to IOUs; POU renewable procurement plans also reflected
- **Proposed RES Regulation:** 33% Renewable Energy Standard by 2020, with no restrictions or delivery requirements on out-of-state resources
- **RES Alternative – Bundled RECs Only:** 33% Renewable Energy Standard by 2020, with a requirement that Out-of-State REC transactions must include energy purchase
- **RES Alternative – In-State Only:** 33% Renewable Energy Standard by 2020, Out-of-State resources do not qualify



Results identical for these cases



Energy+Environmental Economics

5

Updates to Model Since April 5 Workshop

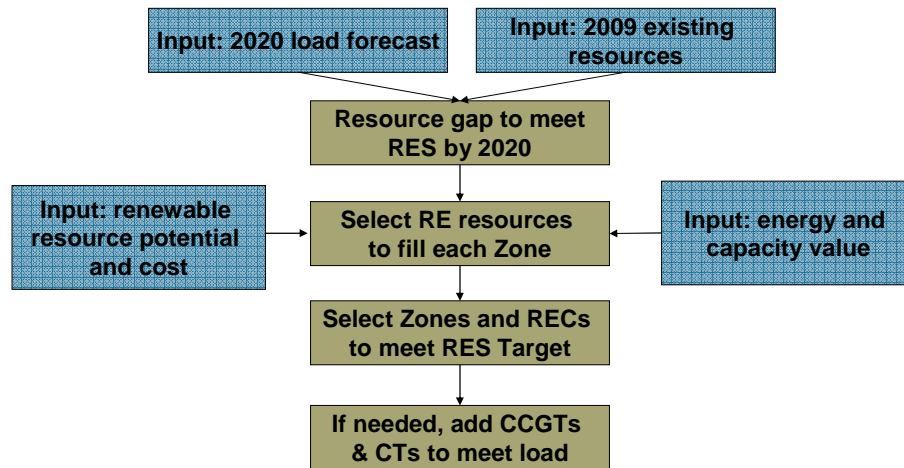
- **Out-of-State RECs:** Completed modeling of REC transactions
- **Utility procurement:** Updated model with latest publicly-available information regarding IOU and POU procurement activities
- **PV Costs:** Reduced solar PV costs from \$4500 to \$4000/kW
- **CO2 pricing:** Set CO2 price to zero
- **CO2 emissions:** revamped methodology for calculating regulated CO2 emissions in California and the rest of the WECC
- **Criteria pollutant emissions:** added module for calculating criteria pollutant emissions in California and the rest of the WECC
- **Biomass and biogas:** Restricted supply in difficult air districts



Energy+Environmental Economics

6

Portfolio Development Process



Energy+Environmental Economics

7

Four Types of New Resources to Fill Resource Gap

1. IOU and POU Procurement Data
 - ❑ IOUs: Contracted projects with status information from CPUC public spreadsheet
 - ❑ POUs: Provided ARB with information about procurement plans by resource type
2. In-state theoretical projects from Renewable Energy Transmission Initiative (RETI)
 - ❑ Pre-identified and proxy projects for California
3. Out-of-State theoretical projects from NREL/EIA
 - ❑ Estimates of renewable resource availability by resource class for out-of-state regions
4. E3/B&V estimates of renewable DG resource potential



Energy+Environmental Economics

8

Project Ranking: Modified RETI Ranking Methodology

■ Steps for selecting resources

1. Rank projects within each Zone
2. Select projects to fill fixed-size transmission line
3. Rank and select zones to meet RES target

■ IOU and POU projects float to top of ranking

- Only selected if entire zone is selected

Project Ranking Formula

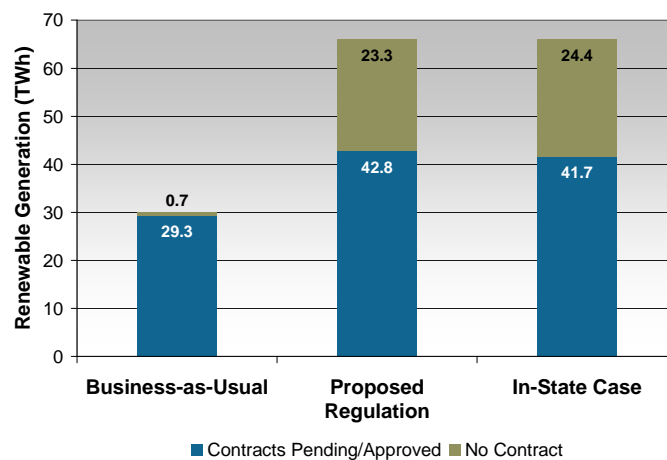
+ Levelized cost of energy
 + Interconnection (gen-tie) costs
 + Deemed integration costs
 + Levelized, per-MWh incremental transmission costs
 – Energy value
 – Capacity value
 – T&D avoided costs
 – Adjustment for IOU/POU Projects
 = Final project rank



Energy+Environmental Economics

9

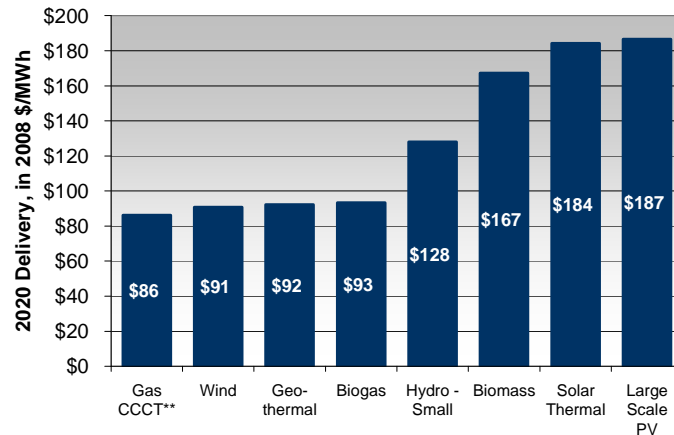
Pending/Approved Contract Additions



Energy+Environmental Economics

10

Levelized Cost of Energy from “Generic” Resources (\$/MWh)



Energy+Environmental Economics

11

Calculating Ratepayer Impacts

- Cost impact of 33% RES to electric ratepayers is equal to:

2020 statewide revenue requirement under the 33% RES case

MINUS

2020 statewide revenue requirement under current statute (20% RPS for IOUs, POU planned procurement)

2020 Revenue Requirement

- + Existing T&D cost
- + New T&D caused by organic growth
- + Fixed & variable costs of existing Gen.
- + Annualized cost of new renewables
- + Renewables integration costs
- + Annualized cost of new transmission for renewables
- + Annualized capital cost of new conventional resources
- + Cost of unspecified energy (market purchases)
- + Net cost of CO₂ allowances
- = 2020 Revenue Requirement



Energy+Environmental Economics

12



Treatment of Out-of-State REC Transactions

Overview

- 33% RES model includes the ability to select both in-state and out-of-state resources
- Out-of-state resources modeled in two ways:
 - Out-of-State CREZs: Out-of-state resources in a CREZ delivered over a new transmission line
 - Out-of-State RECs: Out-of-state resources delivered over existing transmission
 - Bundled vs. unbundled, with or without delivery requirement
- Model assumes physical limits on Out-of-State RECs
- User can also select policy limits on allowable RECs



What is a REC?

- Renewable Energy Credit or Certificate that represents the renewable energy “attribute” of a qualifying resource
- The GHG emissions attribute is separate, but is usually packaged with the REC
- Used to demonstrate compliance with a renewable energy mandate
 - Definition varies by jurisdiction and not all RECs are fungible across all jurisdictions
 - Very useful as a short-term tool for balancing positions
 - Less useful as a long-term tool for promoting investment



Energy+Environmental Economics

15

In-State vs. Out-of-State Resources

- Impact on Ratepayers
 - Allowing out-of-state RECs will increase compliance options and, therefore, reduce costs to California ratepayers
 - There is no difference in pricing between different types of RECs (bundled vs. unbundled, with or without delivery requirement)
- Impact on Emissions
 - No difference in CO2 reductions for in-state vs. out-of-state RECs
 - In-state resources will result in greater reductions to in-state criteria pollutant emissions
- Macroeconomic Impacts
 - In-state resources may result in greater macroeconomic benefit (if benefits from investment stimulus outweigh higher ratepayer costs)



Energy+Environmental Economics

16

Unbundled Out-of-State REC Transaction



Energy+Environmental Economics

- Pure REC transaction with no energy purchase requirement and no delivery requirement
- Developer sells energy at Mid-C
- California LSE purchases REC from developer at LCOE minus Mid-C price
- Separately, California LSE arranges for energy transaction from CAISO market to load
- California LSE never owns energy
- No incremental imports to California

17

Bundled* Out-of-State REC Transaction



Energy+Environmental Economics

- REC transaction with energy purchase requirement but no delivery requirement (*ARB Definition)
- California LSE purchases energy and REC from developer at LCOE of wind facility and sells energy at Mid-C
- Separately, California LSE arranges for energy transaction from CAISO market to load
- Identical to scheduling in-state wind energy into CAISO market
- No incremental imports to California

18

Bundled Out-of-State REC with Delivery Requirement



- REC transaction with energy purchase requirement and delivery requirement
- California LSE purchases energy and REC from developer at LCOE of wind facility and sells energy at Mid-C
- Separately, California LSE arranges for energy transaction from CAISO market to load
- California LSE rebundles REC with energy transaction from Mid-C to CAISO *that would have occurred anyway!*
- No incremental imports to California



Energy+Environmental Economics

19

Pricing of Out-of-State REC vs. In-State Resource

- In-State Resource priced at LCOE, but effect on ratepayers is cost relative to market value or "Green Premium"
- Out-of-State REC priced directly at "Green Premium"
- REC pricing based on marginal resource with good access to transmission, not highest quality resource
- Pricing is the same for all flavors of RECs

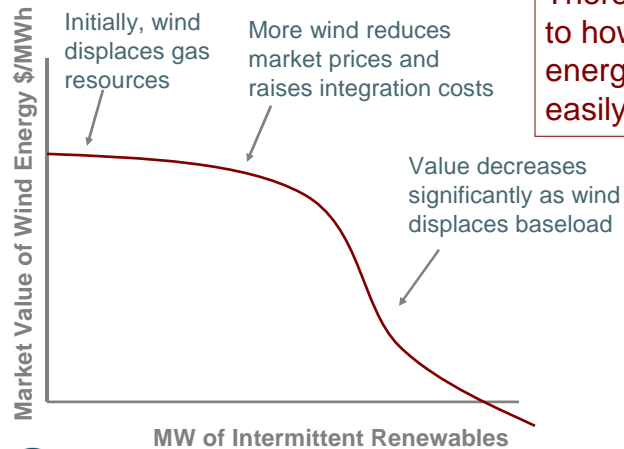
	In-State Wind Resource	Out-of- State Wind REC
Levelized Cost of Wind Energy	\$ 90.00	\$ 75.00
Integration Costs in Local Market	\$ 6.00	\$ 6.00
Energy Value in Local Market (Mid-C or Palo Verde)	\$ (55.00)	\$ (45.00)
Capacity Value in Local Market (Mid-C or Palo Verde)	\$ (5.00)	\$ -
Net Cost to CA Ratepayers ("Green Premium")	\$ 36.00	\$ 36.00
REC Price	\$ -	\$ 36.00



Energy+Environmental Economics

20

Physical Limits on Out-of-State REC Supply



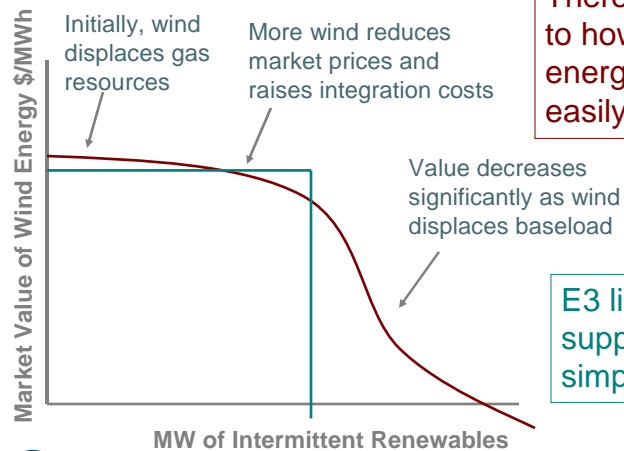
There is a practical limit to how much intermittent energy each zone can easily accept



Energy+Environmental Economics

21

Physical Limits on Out-of-State REC Supply



There is a practical limit to how much intermittent energy each zone can easily accept

E3 limited the REC supply based on a simplified representation

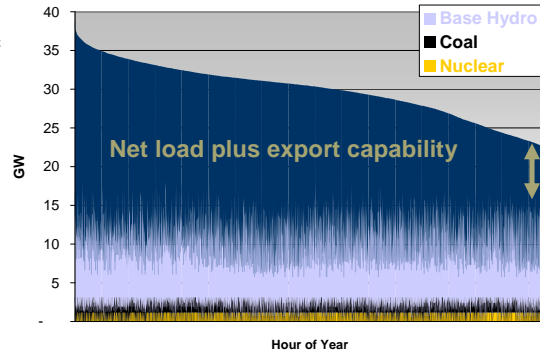


Energy+Environmental Economics

22

Limits on Wind Penetration in WECC Zones

- Ability to “easily” absorb wind is limited by amount of flexible generation online
- E3 estimated hourly flexible generation (Load – baseload generation) in each zone based on production simulation runs
- Can also export wind to region with more flexible generation
 - Added export transmission capability



Wind limit = Load – Nuclear – Coal – Base Hydro + Export Transmission Capability

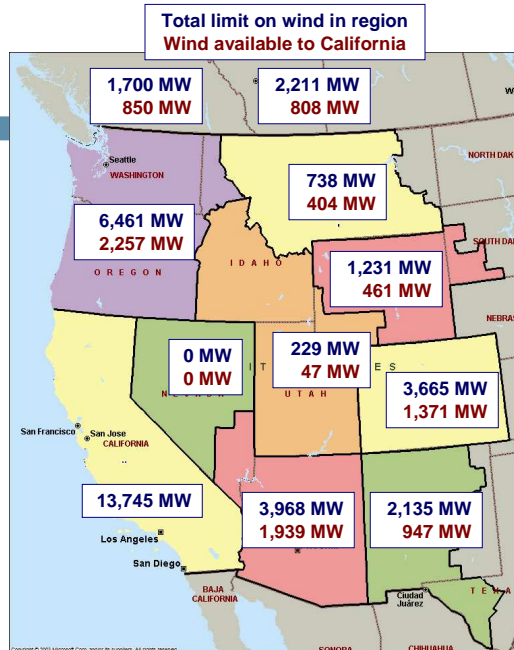


Energy+Environmental Economics

23

Resulting Limits by Region

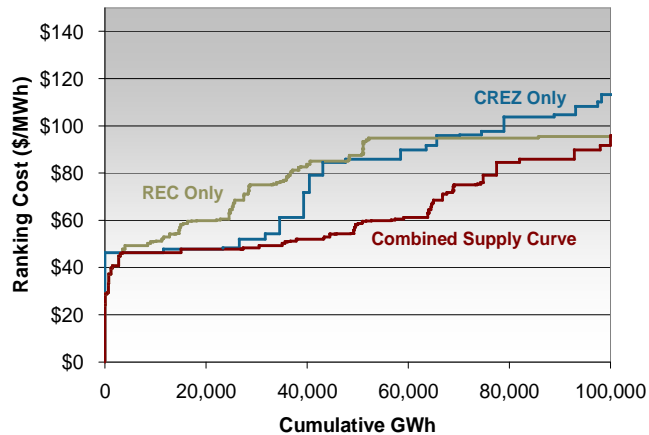
- Total wind that can “easily” be absorbed in WECC:
 - 22,338 MW (excluding CA)
- Subtract existing plus near-term wind:
 - 4,200 MW outside CA
- Assume CA can soak up 50% of each region’s remaining wind limit
- Total limit on wind RECs available to California:
 - 9,084 MW



Energy+Environmental Economics

24

Supply Curve for Compliance



Energy+Environmental Economics

25



Energy+Environmental Economics

Draft Results

* Note: All results presented for High Net Short load case

Zones Selected

Delivered Renewables by Zone

	MW			GWh		
	BAU	Proposed Reg	In-State Case	BAU	Proposed Reg	In-State Case
Total	5,355	15,712	16,185	20,401	55,163	56,520
Distributed CPUC Database	2,349	2,349	2,349	11,787	11,787	11,787
Tehachapi	3,000	3,000	3,000	8,565	8,565	8,565
Imperial North	6	1,500	1,500	48	11,577	11,577
Pisgah	-	1,800	1,800	-	4,395	4,395
Solano	-	1,000	1,000	-	3,189	3,189
Fairmont	-	1,650	1,650	-	4,743	4,743
Mountain Pass	-	1,650	1,650	-	4,282	4,282
Riverside East	-	2,763	3,000	-	6,623	7,191
Palm Springs	-	-	236	-	-	790
Baja	-	-	-	-	-	-
Imperial South	-	-	-	-	-	-

Out-of-State REC Transactions

	MW			GWh		
	BAU	Proposed Reg	In-State Case	BAU	Proposed Reg	In-State Case
Total	3,250	3,674	3,250	9,571	10,929	9,571
Arizona-Southern Nevada - REC	1,010	1,010	1,010	2,464	2,464	2,464
British Columbia - REC	100	100	100	442	442	442
Northwest - REC	1,569	1,569	1,569	4,551	4,551	4,551
Montana - REC	351	351	351	1,016	1,016	1,016
Utah-Southern Idaho - REC	51	51	51	333	333	333
Wyoming - REC	119	119	119	385	385	385
Reno Area/Dixie Valley - REC	50	50	50	381	381	381
Alberta - REC	-	392	-	-	1,133	-
New Mexico - REC	-	32	-	-	224	-
Colorado - REC	-	-	-	-	-	-



Energy+Environmental Economics

27

Resources Added – Business-as-Usual

Resources Added to Meet Target

	In-State		Out-of-State*		Total	
	MW	GWh	MW	GWh	MW	GWh
Biogas	176	1,309	2	16	178	1,325
Biomass	165	1,153	2	12	166	1,165
Geothermal	859	6,538	89	680	948	7,218
Hydro - Small	49	214	121	543	170	757
Solar PV	486	1,064	10	22	496	1,086
Solar Thermal	1,024	2,501	1,000	2,442	2,024	4,943
Wind	2,597	7,621	2,026	5,857	4,623	13,478
Total Additions	5,355	20,401	3,250	9,571	8,605	29,972
Existing Resources		28,804		2,468		31,272
Total Portfolio		49,205		12,039		61,244

*Out-of-State category includes REC-only transactions

Out-of-state percentage: 19.7%



Energy+Environmental Economics

28

Resources Added – Proposed Regulation

Resources Added to Meet Target						
	In-State		Out-of-State*		Total	
	MW	GWh	MW	GWh	MW	GWh
Biogas	176	1,309	2	16	178	1,325
Biomass	165	1,153	34	236	199	1,389
Geothermal	2,353	18,068	89	680	2,442	18,747
Hydro - Small	49	214	121	543	170	757
Solar PV	1,523	3,334	10	22	1,533	3,356
Solar Thermal	5,644	13,815	1,000	2,442	6,644	16,257
Wind	5,803	17,270	2,418	6,990	8,221	24,260
Total	15,712	55,163	3,674	10,929	19,386	66,092
Existing Resources		28,804		2,468		31,272
Total Portfolio		83,967		13,397		97,364

*Out-of-State category includes REC-only transactions

Out-of-state percentage: 13.8%



Energy+Environmental Economics

29

Resources Added – In-State Case

Resources Added to Meet Target						
	In-State		Out-of-State*		Total	
	MW	GWh	MW	GWh	MW	GWh
Biogas	176	1,309	2	16	178	1,325
Biomass	165	1,153	2	12	166	1,165
Geothermal	2,353	18,068	89	680	2,442	18,747
Hydro - Small	49	214	121	543	170	757
Solar PV	1,566	3,430	10	22	1,576	3,451
Solar Thermal	5,838	14,288	1,000	2,442	6,838	16,730
Wind	6,039	18,060	2,026	5,857	8,066	23,917
Total	16,185	56,520	3,250	9,571	19,435	66,092
Existing Resources		28,804		2,468		31,272
Total Portfolio		85,324		12,039		97,364

*Out-of-State category includes REC-only transactions

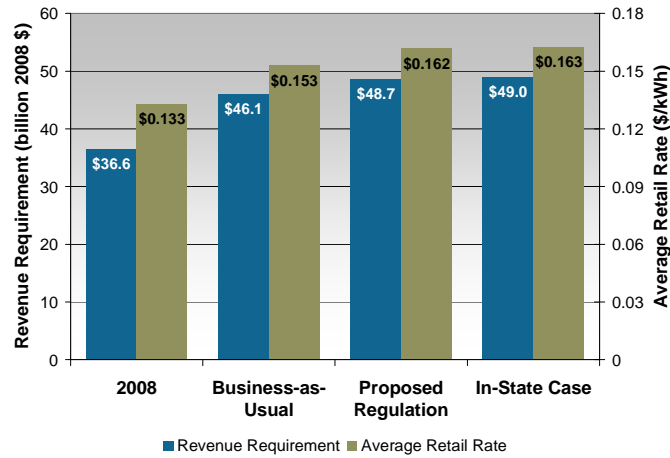
Out-of-state percentage: 12.4%



Energy+Environmental Economics

30

Ratepayer Impact



Energy+Environmental Economics

31

Detailed Revenue Requirement

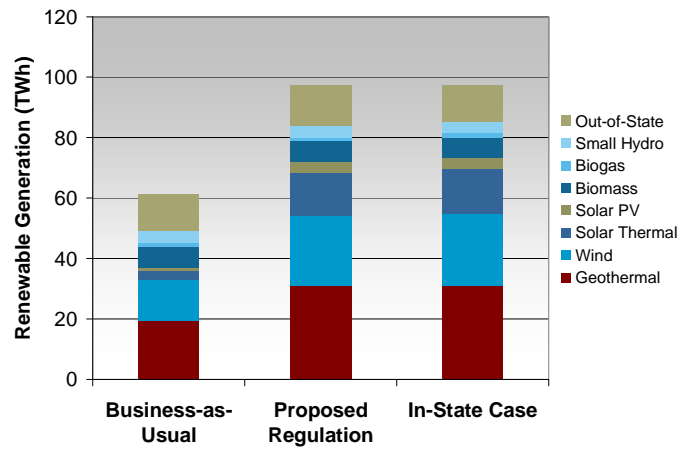
Revenue Requirement Impact (millions of 2008 \$)				
	2008	2020: Business-as-Usual, High Net Short	2020: Proposed Regulation, High Net Short	2020: In-State Case, High Net Short
Existing T&D Costs	15,003	20,124	20,124	20,124
Existing Gen Fixed Costs	8,547	8,547	8,547	8,547
New Conventional Fixed Costs	0	4,232	3,186	3,152
Existing and New Conventional Variable Costs	13,019	10,209	8,473	8,404
Incremental Demand Response Costs	0	0	0	0
New Renewables Build	0	2,859	7,518	7,615
New Transmission for Renewables	0	157	889	1,187
Net CO2 Allowance Costs	0	0	0	0
Total Revenue Requirement	\$36,569	\$46,127	\$48,739	\$49,029
Change Relative to 2008		9,559	12,170	12,461
Change Relative to 2008 (%)		26.1%	33.3%	34.1%
Change Relative to Business-as-Usual			2,611	2,902
Change Relative to Business-as-Usual (%)			5.7%	6.3%



Energy+Environmental Economics

32

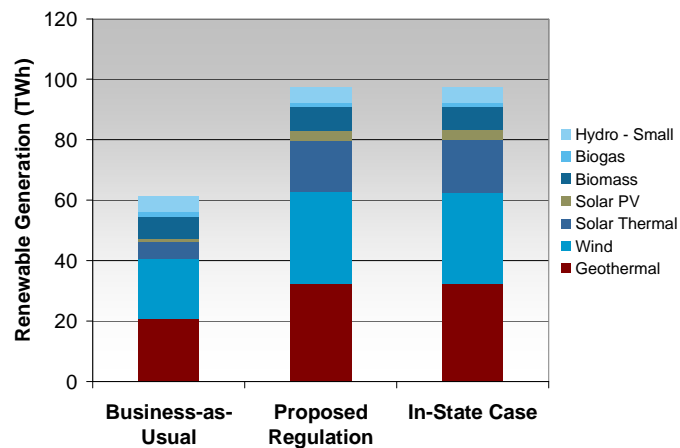
Renewable Resource Mix



Energy+Environmental Economics

33

Renewable Resource Mix



Energy+Environmental Economics

34

Contact Information

Energy and Environmental Economics, Inc. (E3)
101 Montgomery Street, Suite 1600
San Francisco, CA 94104
Phone: 415-391-5100
Fax: 415-391-6500

Arne Olson, Partner (arne@ethree.com)

Nick Schlag, Consultant (nick@ethree.com)



Energy+Environmental Economics

35